The USAF Manufacturing Technology

Program Status Report

Air Force Research Laboratory / Materials & Manufacturing Directorate /
Manufacturing Technology Division / Wright-Patterson AFB, Ohio
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Fall
1999

In this issue:

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Science and Technology for Tomorrow's Aerospace Force

Title III Night Vision Systems Project Improves Capabilities, Saves Millions

Marconi Aerospace Defense Systems and Planar Systems Inc., under a contract with the Air Force Research Laboratory Materials and Manufacturing Directorate (ML), have developed a Night Vision Enhanced Heads Up Display (NVIS EHUD) with dramatically improved capabilities.

The new EHUD is lighter, more reliable, less expensive, and uses commercial off-the-shelf components, which reduces the threat of obsolescence faced by military-unique electronics. With less than a $1 million investment, the system is expected to save more than $6 million initially. Additional savings will be realized if the system is used on Army and Navy aircraft.

Special operations aircrews must fly at very low levels at night. Night vision goggles provide the capability to see in very low light conditions, but pilots must be aware of critical aircraft flight data information without looking into the cockpit. Heads Up Displays (HUD) integrated with night vision goggles help satisfy these needs, but the current system is costly, heavy, unreliable, and impedes movement in the cockpit. The current sys uses a cathode ray tube (CRT) to generate symbology and a fiber optic cable to carry the images to the helmet. The Air Force needed more affordable technology, with higher reliability, greater functionality, and greater safety.

The Defense Production Act (DPA) Title III Program Office initiated this project to qualify a night vision HUD system incorporating small format active matrix electroluminescent (AMEL) flat panel displays, and to help establish a viable domestic production base capable of affordably producing these displays. Prior to this, Marconi conducted a research and development program to evaluate the performance of this display technology, and Planar Systems Inc., had developed the AMEL technology for small displays. In 1997, the Air Force awarded a contract to Marconi/Planar to produce this AMEL flat panel for use in military applications.

The new NVIS EHUD system uses an AMEL flat panel display (rather than a CRT), a circuit card assembly with surface mounted commercial electronics, and a high speed digital data cable in place of the fiber optic cable. The video symbol display unit is smaller, lighter, and its hardware is available commercially. The electro-optical system superimposes flight and navigation symbology onto the scene viewed by operators of night vision goggles. The AMEL display technology increases the type of information normally viewed on the goggles with clear visual acuity, and the mean time between failure increased with the new system from 450 hours to 10,000 hours. The NVIS EHUD costs 32 percent less than the old system, and has an integrated eye piece with rotational focus. During flight tests, users of the new system said it performed exceptionally well. The test group was very satisfied with the ergonomically friendly design and functionality.

The Air Force has purchased four of the new units, and plans to buy an additional

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F33615-93-C-3608

For more information, circle Reader Response Number1

96 units in FY99, with a long range purchase of almost 500 units. This technology can be applied to 3,000 Army and Navy aircraft, and there are potential commercial applications with police departments and the U.S. Customs Service. Title III is a unique program in the DoD arsenal to maintain technology leadership. Its mission is to provide industry with financial incentives to create, expand, and maintain assured, affordable, and commercially viable production capacities for items essential to national defense. The Air Force is the executive agent for the Title III Program and program management is provided by ML's Manufacturing Technology Division.

President of Marconi Aerospace George Melton (left) presents a commemorative photo montage to Dr. Hans Mark, Director of Defense Research and Engineering, in recognition of the successful completion of the Small Flat Panel display project.

Manufacturing Community Heads For Miami Beach For DMC '99

Representatives from government, academia, and industry are currently preparing for the 1999 Defense Manufacturing Conference, slated for Nov. 29 through Dec. 2, in Miami, Fla., at the Fountainbleau Hilton Hotel.

The conference is a forum for discussing and presenting initiatives aimed at addressing defense manufacturing and sustainment needs. Hosted by the Joint Defense Manufacturing (ManTech) Technology Panel, DMC '99 will also provide detailed technical discussions relating to the various initiatives and technology thrusts currently being pursued.

This year's conference is based on the theme, "Manufacturing Into The New Millennium," and will present the status of both government and industry programs as well as a vision for future needs. Much of the conference will be centered around technical sessions and mini-symposiums addressing a variety of topics.

For more information, contact the DMC '99 Exhibit Manager at (937) 426-2808

Multi-Layer Ceramic Substrate Lowers Electronics Packaging Costs

A research effort supported by the Air Force Research Laboratory Materials and Manufacturing Directorate, the Defense Advanced Research Projects Agency (DARPA) and private industry has led to the development of a multi-layer ceramic substrate that reduces the electronics packaging costs for defense systems.

The Low-Temperature-Cofired-Ceramic-on-Metal (LTCC-M) technology uses embedded passive components that facilitate the integration of resistors, capacitors, inductors and microwave transmissions lines into multi-chip substrates.

Integrating passive components into substrates reduces the overall assembly costs by eliminating inventory expense and component attachment and wire bonding operations, and also leads to increased product reliability. Examples of integrated passive components are filters, voltage dividers and impedance matching networks. The first successful example of an LTCC-M substrate with integrated passive components was a wideband 2 to 18 GHz amplifier, designed by Northrop Grumman, which demonstrated the integration of eight capacitors and two resistors. This was followed by the design and fabrication of a direct digital synthesizer which was developed by TRW. The program was performed by the Technology Alliance for Mixed Signal (TAMS), a consortium comprised of researchers from Sarnoff Corporation of Princeton, N.J., and Dielectric Laboratories Inc. (DLI), of Cazenovia, N.Y., under a cooperative agreement with the Air Force Research Laboratory Materials and Manufacturing Directorate.

Sarnoff developed a versatile LTCC-M technology with integrated passive components and transferred this technology to DLI, a merchant supplier, who established a manufacturing facility and then entered the LTCC-M ceramic package and substrate market with its DiPak product line. DLI is currently offering DiPak packages and substrates to frequencies as high as 40 GHz. This effort demonstrated that the combination of a low-loss ceramic, low-loss microwave frequency transmission lines and a high-thermal-conductivity metal core makes LTCC-M suitable for substrates and packages in systems involving communication, mobile computing, electronic warfare and radar. The researchers also demonstrated that the integration of passive components into mixed-signal substrates can greatly reduce module size, enabling more compact product designs having more features than are possible using current packaging and interconnect technology.

As a result of this program LTCC-M successfully demonstrated the integration of digital and microwave circuits on a single substrate. The program also developed a comprehensive design kit for the simulation and layout of multi-layer LTCC-M substrates containing embedded lumped passive components, surface transmission lines and embedded transmission lines. The user-friendly design kit works with the industry standard Hewlett-Packard Communications Design Suite Series IV.

LTCC-M technology permits integration of resistors, capacitors, inductors and microwave transmission lines into multi-chip substrates. Successful transfer of LTCC-M technology lowers packaging cost in advanced communication, mobile computing, electronic warfare, radar and other systems vital to national defense, while advancing technology that could boost production quality in the private sector.

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Cooperative Agreement Number:
F33615-96-2-5105

For more information, circle Reader Response Number 2

Neural Network Model For Machine Tools Improves Accuracy

Under a contract with the Air Force Research Laboratory's Materials and Manufacturing Directorate, engineers from Tetra Precision Incorporated have developed a system which significantly improves the accuracy of commercial grade machine tools.

Incorporating this thermal model in a commercial machine tool can potentially allow the machine tool industry to make significant improvements in accuracy, while saving millions of dollars.

Machine tools are serial-line, open-loop, kinematic chains. At one end of the chain is the part to be machined, and at the other is the cutting tool. One of the major functional requirements of these mechanisms is the ability to position the cutting tool with absolute positioning accuracy on the order of 0.001 percent of the total working volume. Improvement of machine tool accuracy is essential to quality control in manufacturing processes.

There is a constant pressure on industrial manufacturers to produce high quality products while maintaining high productivity. Ninety percent of the cost of ensuring quality is due to scrapping or reworking of parts that do not lie within design tolerances, and this adds to the cost of the part. Recently, added emphasis has been placed on developing new methods that can help produce the product correctly the first time it is manufactured. These methods must be capable of providing the correct compensatory actions to the machine tools by actively monitoring the error sources of machining processes rather than passively inspecting machined parts.

Under this contract, Tetra Precision Incorporated, of Gainsville, Fla., adopted a direct workspace identification technique where the total error at the cutting tool is measured directly using a new calibration device called the Laser Ball Bar. This device is used in conjunction with a neural network to rapidly build a model of the machine tool for a thermal duty cycle that simulates machining of large workpieces. The system makes use of the self-learning properties of artificial neural networks to predict the net positioning error at an arbitrary point in the workspace, from knowledge of the error at some specified points in the workspace. This knowledge is obtained from the measurement of geometric errors and their thermal variations as well as correlation with other process variables.

In a hypothetical case study of a military gas turbine engine where cost savings of improved machining accuracy is the reduction of scraped raw material during the production process, elimination of 3.5 percent of the scrap rate would decrease the overall cost by $70,000 for a $4 million engine. For a typical production run of about 600 engines, this would amount to $42 million in acquisition savings.

This project developed a robust, cost effective method to position cutting tools with absolute positioning accuracy. The improved machine tool accuracy provided by this system improves quality control, reduces scrap, and has the potential to save millions of dollars through acquisition cost avoidance.

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F33615-95-C-5541

For more information, circle Reader Response Number 3

PAP-E Program Reduces Costs, Saves Time, Money In Electronic Test Equipment

Under a contract with the Air Force Research Laboratory Materials and Manufacturing Directorate (ML), Averstar Incorporated has developed the technology to dramatically reduce the cost and time required to support maintenance test equipment for weapons systems electronics.

The Product Data Exchange using STEP (Standard for the Exchange of Product Data Model), or PDES Application Protocol for Electronics (PAP-E) program reduced the cost to rehost a Test Program Set (TPS) for an electronic assembly from $150,000 to $80,000 and reduced the time needed to complete this from three months to one month.

The PAP-E program evolved out of a DoD study which assessed the problems associated with the use of electrical and electronic product data exchange standards. Printed circuit boards (PCBs) and shop replaceable units (SRUs) were found to represent a significant work load within the Air Logistics Center (ALC) and defense system contractor environments, and the repair activities associated with these components were forecasted to increase. The study pointed out that there would be an increase in handling of product data for modular avionics and that current support capabilities will not be able to handle the repair, test and support requirements that will be levied on the ALCs without standard product data and automation technology.

The PAP-E program was proposed to support advancements in the state-of-the-art technology without losing sight of harmonization needs for the current array of diverse data exchange standards and data standards organizations. The program was intended to research the problem of electronic data exchange and data capture for supporting the maintenance, test and integrated diagnostics of PCBs and multi-chip modules (MCMs). Prior to the development of PAP-E technology, rehosting a TPS (moving the TPS software from one tester to another) was not always economically feasible.

The development of peculiar Automated Test Equipment (ATE) to support individual weapons systems was prevalent in the DoD until the late 1980s. The problem is that peculiar ATE developed for these legacy weapons systems usually carries high lifecycle support costs with a low frequency of utility. Peculiar ATE often uses proprietary data formats with the concurrent risk of future insupportability. PAP-E technology provides an economical solution to this problem by reducing the cost to rehost test program sets from both supportable and insupportable peculiar ATE to a family ATE based on industry standard formats that are adaptable to future rehosts.

The PAP-E demonstration proved that using an information model-based solution to rehost a TPS from one ATE platform to another can yield significant savings. The final demonstration yielded a 15-to-1 improvement in first pass article testing and a 6-to-1 improvement in overall TPS rehost capability. The use of the concordance technology allows existing standards and formats to be supported while formally binding the core test model to actual data. A fully automated PAP-E toolset would have allowed the Navy to save over $667 million to rehost software from six aviation testers. Data provided by the demonstration indicates that a rehost of TPSs for 10 different Rockwell PWAs would yield a 170 to 1,638 percent savings if PAP-E technology were employed.

The technology developed through the PAP-E program will help the ALCs and contractor community handle anticipated electronic repair taskings, reduce the cost to rehost ATE, and will save millions of dollars. This information modeling technology is being transferred to several commercial and government standards efforts.

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For more information, circle Reader Response Number 4

ML Directorate Completes 1999 Roadmap Review/SBIR Days

Air Force Research Laboratory Materials and Manufacturing Directorate (ML) held their combined 1999 Roadmap Review and Small Business Innovation Research (SBIR) Industry Days, July 20-22, in the Dayton Convention Center.

More than 400 leaders from industry, government and academia assembled for the event, which gave a complete overview of the Directorate, its recent organizational changes, and its mission to help industry maintain an affordable defense materials and manufacturing capability.

The Roadmap Review portion provided insight into planned research and development activities and featured breakout workshops on specific technology areas being pursued by ML researchers. The SBIR Industry Days portion provided information on specific topics for aerospace materials research and development which require innovative solutions. Small businesses will compete for research funds to help solve these problems, and the facts presented at SBIR Industry Days will help them prepare strong, competitive proposals.

Dr. Charles Browning, director of the Materials and Manufacturing Directorate, welcomes attendees to the 1999 Roadmap Review and Small Business Innovation Research Industry Days at the Dayton Convention Center.

DATE	PROJECT TITLE CONTRACT NO.	PRIME CONTRACTOR	POINT OF CONTACT
September 1999	Flat Panel Displays Multiple	Boeing Company St Louis, MO	John Blevins (937) 255-3701
September 1999	Design and Manufacture of Low Cost Composites (DMLCC), Engines F33615-91-C-5719	General Electric Company Cincinnati, OH	Marvin Gale (937) 656-9221
September 1999	Automated Data Acquisition for In-Situ Material Process Modeling F33615-97-C-5841	Infoscribe Technologies LTD Beavercreek, OH	John Jones (937) 255-8786
September 1999	Web-Based: Collaborative Cost Analysis of Warfighting Power by the Fighting Hour F33615-99-C-5904	Frontier Technology Incorporated Goleta, CA	David Judson (937) 255-7371
September 1999	Integrated Knowledge Environment - Integrated Product Management (IKE-IPM) F33615-96-C-5109	Knowledge Base Engineering Incorporated Centerville, OH	David Judson (937) 255-7371
September 1999	Advanced Reconfigurable Machine for Flexible Fabrication F33615-95-C-5500	Lockheed Martin Corporation Palo Alto, CA	Deborah Kennedy (937) 904-4392
September 1999	Lean Aerospace Initiative (LAI) F33615-93-2-4316	Massachusetts Institute of Technology Cambridge, MA	John Klempay (937) 255-3701
September 1999	A Non-Invasive Vibration Sensor for the Machine Shop F33615-99-C-5312	A2Z Technologies Corporation Niceville, FL	Rafael Reed (937) 904-4393
September 1999	Precision High Speed Machining with Vibration Control SPO900-94-C-0010	Boeing Company St Louis, MO	Rafael Reed (937) 904-4393
September 1999	F-22 Radar Subarray Manufacturing Process Improvements F33615-97-C-5159	Northrop Grumman Corporation Baltimore, MD	Walter Spaulding (937) 904-4365
September 1999	Multiphase Integrated Engineering Design (MIND) F33615-96-C-5621	University of Utah Salt Lake City, UT	Alan Winn (937) 255-8787
October 1999	Laser Induced Fluoresence Imager for Closer Loop Epitaxial F33615-99-C-5707	Foster-Miller Incorporated Waltham, MA	Steve Fairchild (937) 255-8786
November 1999	Field Level Repair/Joining of Composite Structures F33615-97-C-5125	Foster-Miller Incorporated Waltham, MA	Marvin Gale (937) 656-9221
November 1999	Infrared Focal Plane Array/Flexible Manufacturing F33615-93-C-4320	Texas Instruments Incorporated Dallas, TX	Robert Susnik (937) 255-3812

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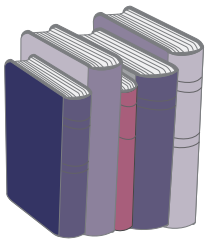
November 1999	Conformable Multichip Assembly Technology F33615-98-C-5149	Epic Technologies Incorporated Woburn, MA	Charles Wagner (937) 904-4591
December 1999	Enhanced Pultruded Composite Materials F33615-96-C-5629	Rust College Holly Springs, MS	Edward Hermes (937) 904-4598
December 1999	Materials Process Design Web Site N/A	Imagination Engines Incorporated St Louis, MO	Steven LeClair (937) 255-8786
December 1999	Robust Design Computational System F33615-96-2-5618	Rockwell International Corporation Canoga Park, CA	Daniel Lewallen (937) 255-4623
December 1999	Simulation Assessment Validation Environments (SAVE) F33615-95-C-5538	Lockheed Martin Corporation Fort Worth, TX	James Poindexter (937) 255-7371
December 1999	Behavior Analog Fault Modeling F33615-96-1-5603	University of Iowa Iowa City, IA	William Russell (937) 255-7371
December 1999	Titanium Matrix Composite Turbine Engine Component Consortium (TMCTECC) F33615-94-2-4439	United Technologies Corporation Pratt & Whitney	Kevin Spitzer (937) 904-4599
January 2000	Advanced Resin System for RTM/VARTM Processing F33615-99-C-5308	Shade Incorporated Lincoln, NE	Frances Abrams (937) 904-4380
January 2000	Semi-Insulating (SI) Indium Phosphide (InP) Wafers F33733-97-C-1022	American Xtal Technology Fremont, CA	John Blevins (937) 255-3701
January 2000	Semi-Insulating (SI) Indium Phosphide (InP) Wafers F33733-97-C-1023	MA Com Incorporated Lowell, MA	John Blevins (937) 255-3701
January 2000	Net Shape Reinforcement Preforms for High Temperature Ceramic & Intermetal F33615-98-C-5201	Foster-Miller Incorporated Waltham, MA	Rollie Dutton (937) 904-4389
January 2000	Advanced Resin System for RTM/VARTM Processing F33615-99-C-5311	Applied Poleramic Incorporated Benicia, CA	Marvin Gale (937) 656-9221
January 2000	Intergation of On-Line Sensors with the CVD Fiber-Coating F33615-99-C-5210	Advanced Technology Materials Danbury, CT	John Jones (937) 255-8786
January 2000	Flexible Environment for Conceptual Design F33615-96-C-5617	Rockwell International Corporation Palo Alto, CA	Daniel Lewallen (937) 255-4623
January 2000	MEREOS - A Product Definition Management System for Enterprise F33615-95-C-5519	Ontek Corporation Laguna Hills, CA	Daniel Lewallen (937) 255-4623

Reports



Activity Based Costing (ABC) for Agile Manufacturing Control

Alog Number: 4195
Contract Number: F33615-95-C-5516
Technical Report Number:
AFRL-ML-WP-TR-1998-4163
Distribution: UNLIMITED

Manufacturing 2005: Textile Apparel Initiative

Alog Number: 4196
Contract Number: F33615-94-C-4430
Technical Report Number:
AFRL-ML-WP-TR-1998-4152
Distribution: LIMITED

Context Integrated Design

Alog Number: 4203
Contract Number: F33615-96-C-5614
Technical Report Number:
AFRL-ML-WP-TR-1998-4072
Distribution: LIMITED

Manufacturing Technology For Tactical Grade Interferometric Fiber Optic Gyroscopes (IFOG)

Alog Number: 4204
Contract Number: F33615-93-C-4321
Technical Report Number:
AFRL-ML-WP-TR-1998-4171
Distribution: LIMITED

Resin Transfer Molding Rapid Prototyping and Tooling (RaPat)

Alog Number: 4208
Contract Number: F33615-95-2-5558
Technical Report Number:
AFRL-ML-WP-TR-1998-4170
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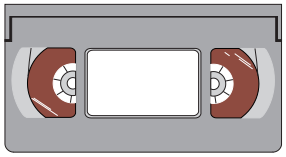

Videos

Thermoscan 88

Alog Number: 109
Length: 13:50
Distribution: LIMITED

ICC Integrated Composite Center

Alog Number: 112
Length: 14:00
Distribution: LIMITED

Robotic Microwave Hybrid Substrate Assembly

Alog Number: 113
Length: 9:50
Distribution: LIMITED

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The USAF Manufacturing Technology

PROGRAM STATUS REPORT

Fall 1999

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